United States Patent [19]

Abbott et al.

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[54] **APPARATUS FOR CONTINUOUS PREPARATION OF TOBACCO**

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[73] Assignee: **FMC Corporation**, San Jose, Calif.

[22] Filed: **Sept. 20, 1971**

[21] Appl. No.: **181,787**

Related U.S. Application Data

[62] Division of Ser. No. 884,850, Dec. 15, 1969, Pat. No. 3,704,716.

[52] **U.S. Cl.** ..... **131/136**, 131/140 P

[51] **Int. Cl.** **A24b 03/18**

[58] **Field of Search** 131/140–144, 133, 136

[56] **References Cited**

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FOREIGN PATENTS OR APPLICATIONS

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OTHER PUBLICATIONS

"Freeze Dehydration Without Vacuum" Article in the magazine Meat, August 1963, pages 28, 29 and 50 cited.

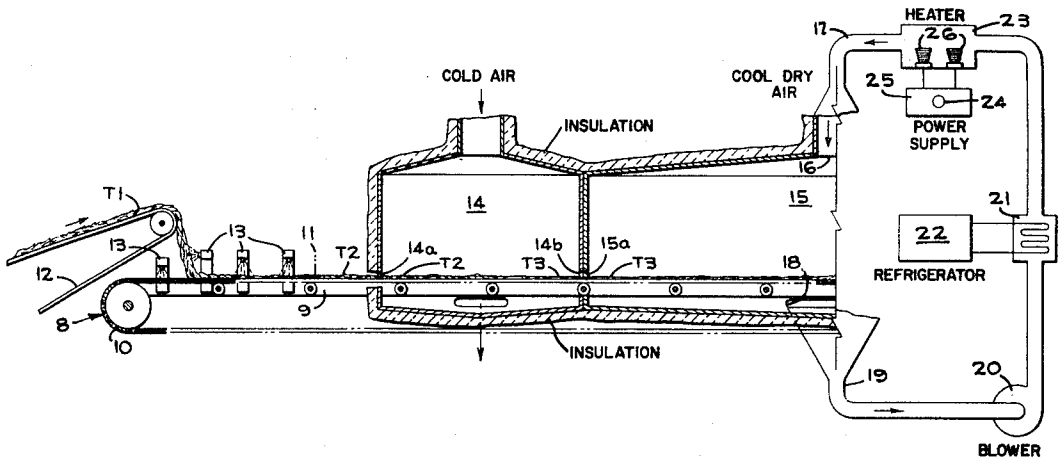
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[57] **ABSTRACT**

Expanded Tobacco in a Continuous Process is disclosed. The apparatus comprises a continuously driven conveyor on which moist tobacco is carried, the conveyor passing through a freezing chamber and a drying chamber. Means are provided to circulate dry cool air at substantially atmospheric pressure within the drying chamber. There is also shown apparatus for continuously lifting soaking tobacco out of a body of water for subsequent freeze drying.

10 Claims, 4 Drawing Figures



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SHEET 1 OF 2

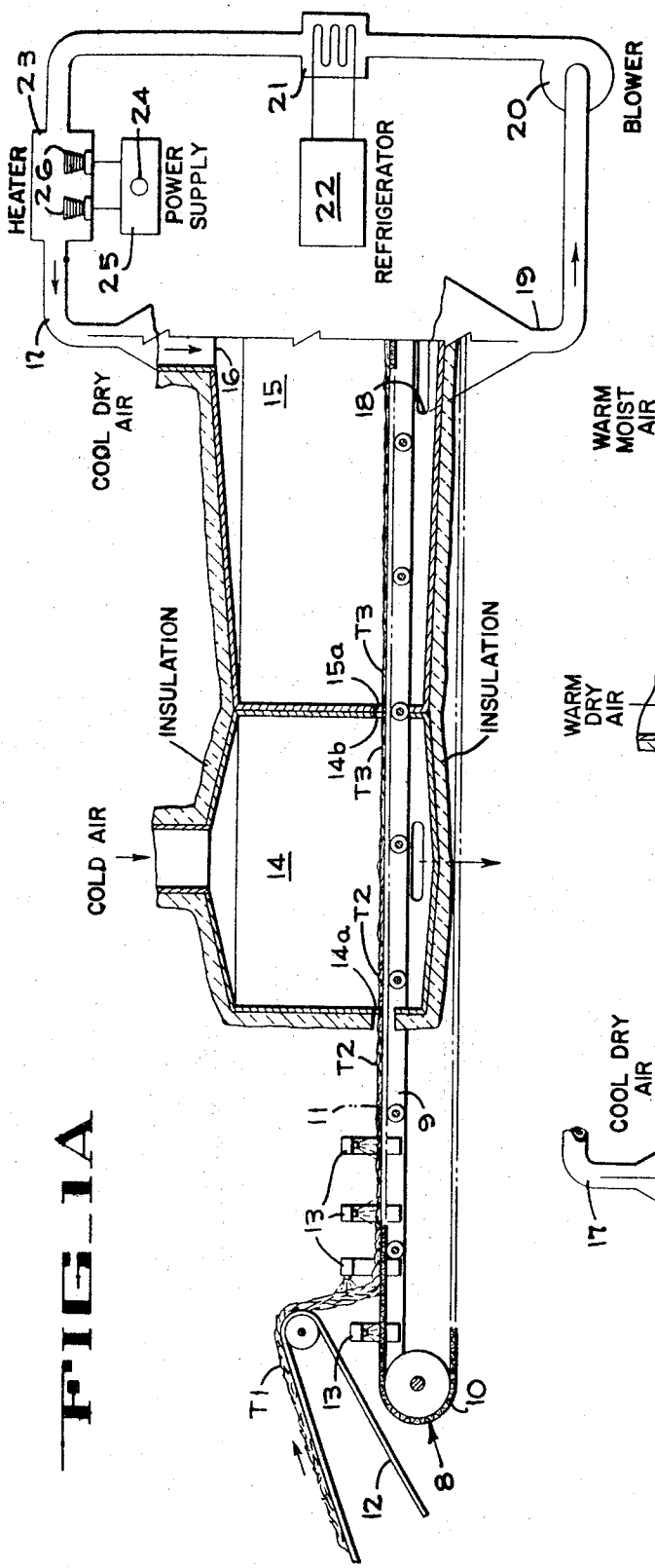


FIG_1A

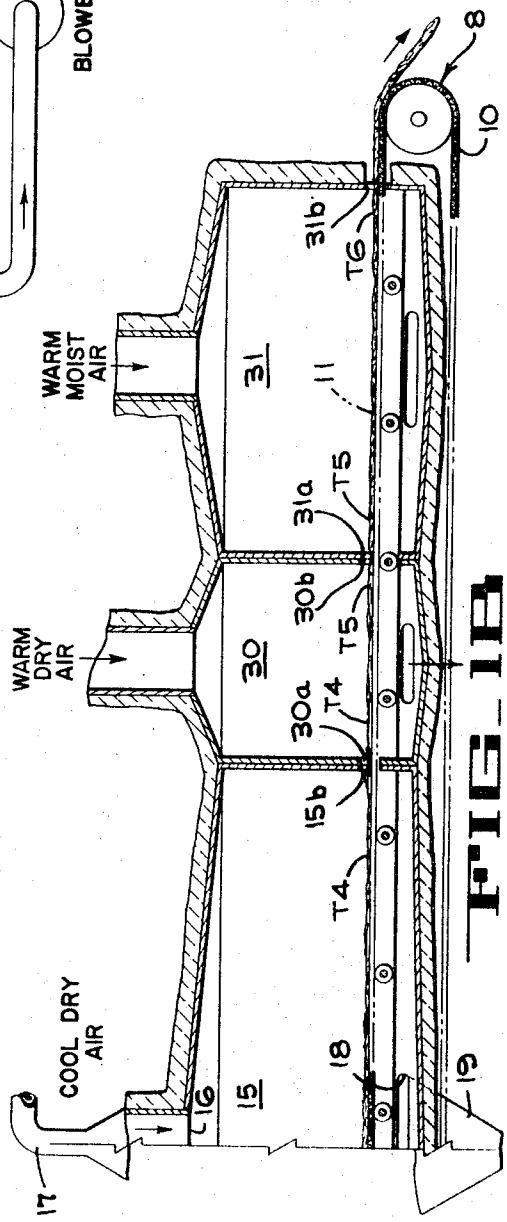


FIG_1B

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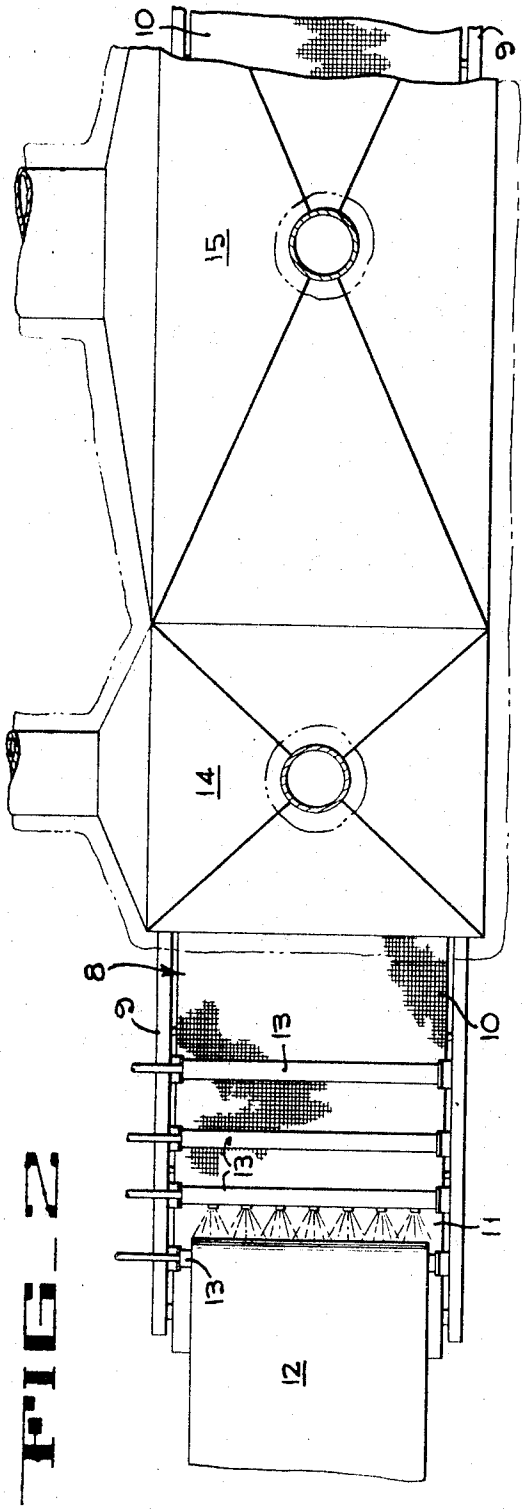


FIG_2

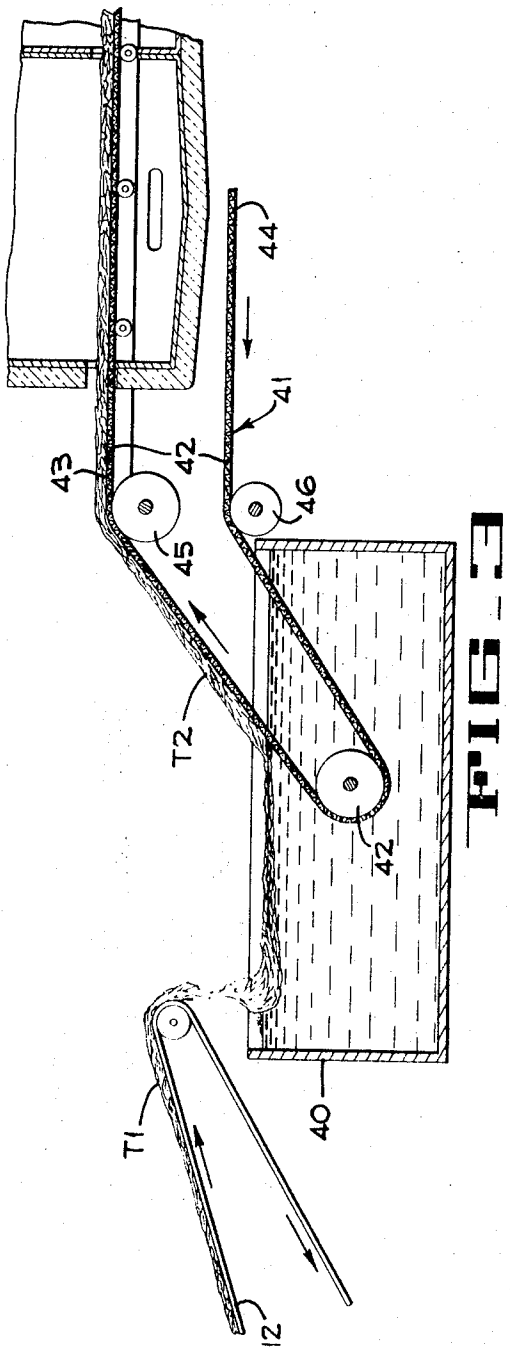


FIG_3

APPARATUS FOR CONTINUOUS PREPARATION OF TOBACCO

The present application is a division of U.S. Pat. application Ser. No. 884,850 filed Dec. 15, 1969, now U.S. Pat. No. 3,704,716, and assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

There has recently been increased interest in the preparation of expanded tobacco for use in cigarettes. One reason for the interest lies in the increasing belief that some of the ingredients of cigarettes, such as tar and nicotine, may be harmful to smokers. It has been recognized that expanded tobacco, by virtue of the expansion thereof, will contain a correspondingly diminished amount of deleterious ingredients when used in a cigarette of a given size. In other words, a cigarette containing expanded tobacco will contain less tobacco by weight, and hence less harmful ingredients, than a cigarette of the same size filled with unexpanded tobacco. Another recognized advantage for the producers of cigarettes of expanded tobacco is the reduction in the quantity of tobacco required to fill a given quantity of cigarettes.

It has been suggested that freeze drying of tobacco will produce a desirable expanded tobacco suitable for cigarettes. However, the tobacco industry requires a huge continuous supply of tobacco which cannot be supplied with conventional freeze drying apparatus unless a tremendous capital investment is made in vacuum equipment for conventional freeze drying.

In conventional freeze drying, a frozen article is placed in a vacuum chamber wherein heat is supplied to the frozen article to cause the mositure in the article to pass from the solid state to the gaseous state without passing through a liquid state. Normally, because of the high vacuum required, freeze drying is done by the limited volume batch process. Continuously supplying frozen tobacco to a vacuum chamber and continuously withdrawing tobacco therefrom would render it extremely expensive to maintain a sufficiently high vacuum in the chamber for the conventional freeze drying process.

SUMMARY OF THE INVENTION

In the present invention, a continuous process, and apparatus therefor, is provided for the preparation of fibrous material, such as tobacco for cigarettes. In one feature of the invention, frozen tobacco is continuously supplied to a drying chamber through which cool air is circulated at essentially atmospheric pressure. The moving air sweeps away the water vapor above the tobacco to reduce the pressure of the water vapor at the surface of the tobacco. In freeze drying, prompt removal of water vapor at the surface of the article is necessary for passage of the frozen moisture directly to the gaseous state, and a high vacuum, as used in conventional freeze drying, is useful to facilitate this transfer. But dry cool air blown past the article to sweep away water-vapor molecules as they reach the surface of the article can also be used, as described more fully in Science, Vol. 130, Sept. 11, 1959, pages 628–629, and in Meat, July and August 1963, pages 34 and 26, respectively. Frozen shredded tobacco, which has a high freezing point and a relatively large surface area per unit of mass is especially well suited to this type of drying.

In the present invention, frozen tobacco is moved continuously while being frozen, as through a freezing chamber, and while being freeze dried, as through a drying chamber through which cool air is circulated to atmospheric pressure. In the preferred form of the invention, the tobacco is only partially freeze dried, to save time, and is moved from the freeze drying chamber to a chamber for drying with air of higher temperature. Thereafter, the dried tobacco, which is now greatly expanded from its original state, is rehumidified to facilitate handling.

In its initial state, the tobacco is typically dry (with about a 10 to 13 percent moisture content) and in the form of shrunken shreds. The tobacco is first moistened for expansion, either by passing the tobacco under a water spray or floating the tobacco in a body of water. In the latter instance, a wire mesh conveyor passes through the surface of the water to raise and drain the water soaked tobacco. When the expanded tobacco is subsequently freeze dried as described above, the tobacco will remain in the expanded condition even after drying.

The tobacco is fed preferably by a continuously moving belt from a source of supply through the wetting step to a succession of separate chambers, in each of which a separate treatment is performed on the tobacco, so that fully processed tobacco is continuously delivered from the final downstream chamber.

It is therefore one object of the present invention to provide apparatus for the continuous freeze drying of shredded fibrous material to produce an expanded material.

It is another object of the present invention to provide for continuous freeze drying of tobacco at atmospheric pressure.

It is yet another object of the present invention to continuously soak tobacco and raise the tobacco for transfer into a freezer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are side views, in cross section, of apparatus constructed in accordance with one form of the invention for preparing tobacco for use in cigarettes, showing schematically one form of apparatus for supplying air of the desired temperature and relative humidity to one of the chambers;

FIG. 2 is a fragmentary plan view of the apparatus of FIG. 1; and

FIG. 3 is a side view, in cross-section, of apparatus constructed according to one feature of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

There is shown in FIGS. 1A and 1B apparatus for continuously expanding tobacco for use in cigarettes. A conveyor **8**, mounted on conveyor frame 9 (FIG. 2) has an endless wire mesh conveyor belt **10**, with a horizontal upper run **11**. Tobacco T1, which is shredded (to, say, 50 cuts per inch) and dry (say 10 to 13 percent moisture) is continuously deposited on the downstream end of the conveyor from a supply conveyor **12**. A plurality of sprinkler manifolds **13** above the upper run **11** of the belt extend across the conveyor to continuously discharge water on the belt **10**, the tobacco T1 falling onto the belt, and the tobacco on the belt. On wetting,

the tobacco expands typically 2.6 times and contains 70 to 80 percent moisture. The wet, expanded tobacco is designated as T2.

The conveyor **8** extends through inlet and outlet openings **14***a*, **14***b* of an enclosed insulated freezing chamber **14** through which cold air, at about 0°F, is circulated to freeze the wet tobacco which is continuously moving through the chamber **14** on the belt **10.** The frozen tobacco is indicated as T3.

From the chamber **14,** the conveyor **8** extends through inlet and outlet openings **15***a*, **15***b* of an insulated drying chamber **15.** The chamber **15,** which is enclosed, has an air inlet opening **16** in communication with an inlet duct **17** and has an outlet opening **18** in communication with an outlet duct **19.** As shown schematically in FIG. 1A, air is drawn from chamber **15** and through duct **19** by a blower **20** connected to the duct **19.** The blower **20** discharges air through a cooling chamber **21** where the air is cooled to typically −20° by a refrigerator unit **22.** Moisture is condensed out of the air in the cooling chamber and when the air, which is carried through heater **23** to inlet duct **17,** is subsequently heated in the heater to about 30°, the air becomes very dry. The dry air from heater **23** passes into the inlet duct **17** for circulation through chamber **15.** The final temperature of the air introduced to the chamber **15** can be regulated by the adjustable knob **24** on the electric power supply **25** which transmits electrical energy to the heating elements **26.** Another method of supplying dry air would be to circulate the air through a bed of solid particulate dessicant, such as silica gel or materials known commercially as molecular sieves. Thus, dry (relative humidity less than 10 percent) and cool air (about 30°F) is continuously circulated through the chamber **15.** Although air at the temperature and relative humidity indicated is preferred, it is only necessary that the air have a temperature and humidity so that the wet bulb temperature thereof is below the freezing point of the water soaked tobacco.

The dry cool air circulating through chamber **15** penetrates the frozen tobacco T3 and sweeps away the water molecules from the surface of the shredded tobacco, which has a relatively large surface area. The rate of release of the water vapor from the frozen tobacco T3 is controlled primarily by the water vapor pressure at the surface of the tobacco rather than by total gas pressure. Although in conventional freeze drying, a vacuum is used to reduce the water-vapor pressure at the surface of the article being freeze-dried, the circulating dry, cool air will also effectively reduce the water-vapor pressure at the surface of material, such as the fibrous shredded tobacco. Thus, as in conventional freeze drying, the water vapor in the shredded tobacco will pass directly to gaseous vapor without passing through the liquid stage. This sublimation of the vapor in the tobacco will completely dry the tobacco, without shrinking the tobacco from the expanded state, if the continuously moving tobacco is exposed for a sufficiently long time to the cool dry air of the drying chamber **15,** which, for convenience, may be referred to as a first drying chamber. If the tobacco is exposed for a lesser time to the air circulating through chamber **15,** the tobacco will be only partially dried. The partially dried tobacco is indicated at T4.

In order to save time in the drying cycle, a second insulated drying chamber **30** may be provided, directly downstream (with respect to the direction of tobacco travel on the conveyor **8**) from the first drying chamber **15.** The conveyor **8** extends through inlet and outlet openings **30***a*, **30***b* in the chamber **30** and carries the tobacco through that chamber for completion of the drying. The drying is completed quickly by the circulation of warm (say 100°F), dry (say 10 percent relative humidity) air through the chamber. Although air at the temperature and humidity indicated is preferred, it is only necessary that the air be at a temperature and humidity so that the wet bulb temperature thereof is above the freezing point of the partially freeze dried tobacco. The completely dried tobacco is indicated at T5. As the remaining vapor in the tobacco dries in chamber **30,** the vapor passes through the liquid stage before finally evaporating. For this reason, it is preferable to freeze dry at least 90 percent of the moisture from the tobacco in chamber **15** so that there will not be a significant shrinkage of the tobacco when the remaining vapor passes through the liquid stage in chamber **30.**

After the final drying, the tobacco is completely dry and brittle, although remaining in the expanded state of over twice the size of the original tobacco T1. In order to facilitate further handling, the tobacco moves on conveyor **8** through inlet opening and outlet opening **31***a*, **31***b* of an insulated rehumidifying chamber **31.** Warm moisture air (of, for example, 80 percent relative humidity and 80°F) is circulated through the chamber to add moisture, say 10 to 13 percent, to the dry tobacco. The rehumidified tobacco is indicated at T6.

The tobacco thus is carried by the wire mesh conveyor successively and continuously through a wetting operation, and insulated chambers **14, 15, 30, 31** for separate treatment in each of the chambers while the tobacco is moved through the chambers. The tobacco in its processed form is continuously discharged through opening **31***b* of the final downstream chamber **31.**

In lieu of wetting the tobacco by sprinkling, the tobacco T1 may, instead, be dropped into a tank **40** from the supply conveyor **12.** The tank **40** is filled with water which soaks the tobacco to a moisute content of 70 to 90 percent. The downstream end of a conveyor **41** has a drum **42** mounted in the tank **40** below the surface of the water. An endless wire mesh conveyor belt **42,** having an upper run **43** and a lower run **44,** is received over drum **42.** The wire mesh conveyor belt, which defines a continuous screen, has small closely spaced openings through which excess water drains. Two vertically spaced drums **45, 46** are positioned above the tank at the downstream end thereof. The upper run **43** of the conveyor belt is received over the upper drum **45** and the lower run **44** of the conveyor belt is received over the lower drum **46.** The upper run **43** of the conveyor belt extends through a series of chambers similar to the construction shown in FIGS. 1A and 1B.

As a continuous supply of tobacco T1 drops off the end of supply conveyor **12,** it floats on the water in the tank. The continuous supply of tobacco spreads across the water until the floating, soaked, tobacco contacts the wire mesh conveyor run **43** as it emerges through the surface of the water. The wetted tobacco T2 is then picked up and carried through the processing steps previously described in conjunction with FIGS. 1A and 1B.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and

variation may be made without departing from what is regarded to be the subject matter of the invention.

What is claimed is:

1. Apparatus for freeze drying tobacco in a continuous process comprising in combination a conveyor to transport moist tobacco downstream, means for continuously driving said conveyor to transport said tobacco at a constant rate of speed, a freezing chamber in the path of the conveyor to freeze the moist tobacco thereon, a drying chamber in the path of the conveyor downstream from the freezing chamber, and means to circulate cool dry air at substantially atmospheric pressure through the drying chamber to freeze dry the frozen tobacco.

2. Apparatus for freeze drying tobacco in a continuous process comprising in combination a conveyor to transport moist tobacco downstream, means for continuously driving said conveyor to transport said tobacco at a constant rate of speed, a freezing chamber in the path of the conveyor to freeze the moist tobacco, a first drying chamber in the path of the conveyor downstream from the freezing chamber, means to circulate cool dry air at substantially atmospheric pressure through the drying chamber to partially freeze dry the frozen tobacco, a second drying chamber in the path of the conveyor, and means to circulate warm dry air at substantially atmospheric pressure through the second drying chamber to further dry the tobacco.

3. Apparatus according to claim 2 including a moistening chamber in the path of the conveyor and downstream from the second drying chamber to rehumidify the tobacco for handling.

4. Apparatus according to claim 3 including means for continuously driving said conveyor.

5. Apparatus according to claim 4 wherein said conveyor comprises an open mesh endless conveyor belt.

6. Apparatus according to claim 4 including means spaced upstream from said freezing chamber for continuously supplying wetted tobacco to said conveyor.

7. Apparatus for freeze drying tobacco in a continuous process comprising in combination a tank for containing a body of water and continuously receiving tobacco dumped therein, an open mesh endless conveyor belt with a lower run and an upper run for transporting moist tobacco downstream, said conveyor belt having its upstream end submerged beneath the surface of the water whereby the upper run of the conveyor belt is arranged to lift floating tobacco from said tank and to carry the tobacco to said freezing chamber, means for continuously driving said conveyor, a freezing chamber in the path of the conveyor to freeze the moist tobacco thereon, a drying chamber in the path of the conveyor downstream from the freezing chamber, and means to circulate cool dry air through the drying chamber to freeze dry the frozen tobacco.

8. Apparatus according to claim 7 including a second conveyor arranged to continuously dump tobacco into said tank.

9. Apparatus for freeze drying moist tobacco by a continuous process at a constant rate of freeze drying including a means for moistening thin shreds of tobacco, a freezing chamber for freezing the moist tobacco, a freeze drying chamber, a tobacco conveying means passing through the tobacco moistening means and the freezing chamber and the freeze drying chamber in one continuous path, said freeze drying chamber being located downstream from the freezing chamber and said freezing chamber being located downstream from said tobacco moistening means, and an air cooling means for circulating within the freeze drying chamber cool dry air, said conveying means transporting the frozen tobacco into thermal communication with the cool dry air.

10. Apparatus for freeze drying moist tobacco by a continuous process including a freezing chamber for freezing moist thin shreds of tobacco therein, a freeze drying chamber, a tobacco conveying means passing through the freezing chamber and the freeze drying chamber along a substantially horizontal linear path, means for driving said conveying means at a constant linear speed, said freeze drying chamber being located downstream from the freezing chamber, and an air cooling means for circulating within the freeze drying chamber cool dry air at substantially atmospheric pressure thereby continuously freeze drying at a constant rate said tobacco which passes through said freeze drying chamber.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,749,103

DATED : July 31, 1973

INVENTOR(S) : JOHN A. ABBOTT ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the abstract - Insert before "expanded" -- Apparatus for the production of --.

Column 2, line 6 - change "to" to -- at --.

Column 4, line 27 - change "moisture" to -- moist --.

Signed and sealed this 27th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks